



HAL
open science

APISENSE®: Mobile crowd-sensing made easy!

Romain Rouvoy

► **To cite this version:**

| Romain Rouvoy. APISENSE®: Mobile crowd-sensing made easy!. 2016. hal-01332594

HAL Id: hal-01332594

<https://inria.hal.science/hal-01332594>

Submitted on 13 Oct 2016

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



@RomainRouvoy







Spirals

Self-adaptation for distributed services and large software systems

[Home](#)[Members](#)[Publications](#)[Software](#)[Fundings](#)[Contact](#)[Intranet](#)

Presentation



Spirals is conducting research activities in the domains of distributed systems and software engineering.

Spirals aims at introducing more automation in the adaptation mechanisms of software systems, in particular, transitioning from adaptive systems to **self-adaptive systems**. Spirals targets especially two properties: **self-healing** and **self-optimization**. With self-healing, Spirals aims at studying and tailoring data mining and machine learning solutions for the design and implementation of software systems. This contributes to the goal of obtaining solutions for **automatic software repair**. With self-optimization, Spirals aims at sharing, collecting, and analyzing distributed behaviors and data to continuously tailor, optimize, and keep under working conditions software systems. This participates to the goal of obtaining eternal distributed systems.

Spirals is a joint project-team between **Inria** and the **University of Lille – Sciences and Technologies** within UMR 9189 **CRISTAL**. Spirals originates from the **ADAM** project-team (2008-13).



Available Positions

- PhD & Internship
[Privacy-aware data dissemination in mobile networks](#)
- Cartography of the Quality of Experience for Mobile Internet Access
- R&D Engineer
[Développeur applications mobiles pour plateforme de géolocalisation indoor](#)
- [Research Software Engineer in Automatic Repair](#)

Links

- [Software Engineering seminar](#)
- [Somca Inria associated team](#)
- [Videos](#)

Spirals Twitter

Tweets by [@SpiralsTeam](#)

Spirals Team Retweeted

IEEE Software
[@ieeesoftware](#)



RAW DAD

A Community Resource for Archiving Wireless Data At Dartmouth



mirrors:

- News
- [Join the CRAWDAD community](#)
- [Reset your CRAWDAD account password](#)
- [Datasets and tools by name](#)
- [Datasets and tools by release date](#)
- Datasets and tools by keyword:
 - Select one
- Datasets by measurement purpose:
 - Select one
- [About the CRAWDAD project](#)
- [CRAWDAD references in CiteULike](#)
- [CRAWDAD contributors by country](#)
- [CRAWDAD members by country](#)
- Open "crawdad.org/index.html" in a new tab

Welcome to CRAWDAD

CRAWDAD is the Community Resource for Archiving Wireless Data At Dartmouth, a wireless network data resource for the research community. This archive has the capacity to store wireless trace data from many contributing locations, and staff to develop better tools for collecting, anonymizing, and analyzing the data. We work with community leaders to ensure that the archive meets the needs of the research community.

CRAWDAD is grateful to its current and past [sponsors](#).

Latest News

new version of CRAWDAD dataset - factory channel gain measurements - June 13, 2016

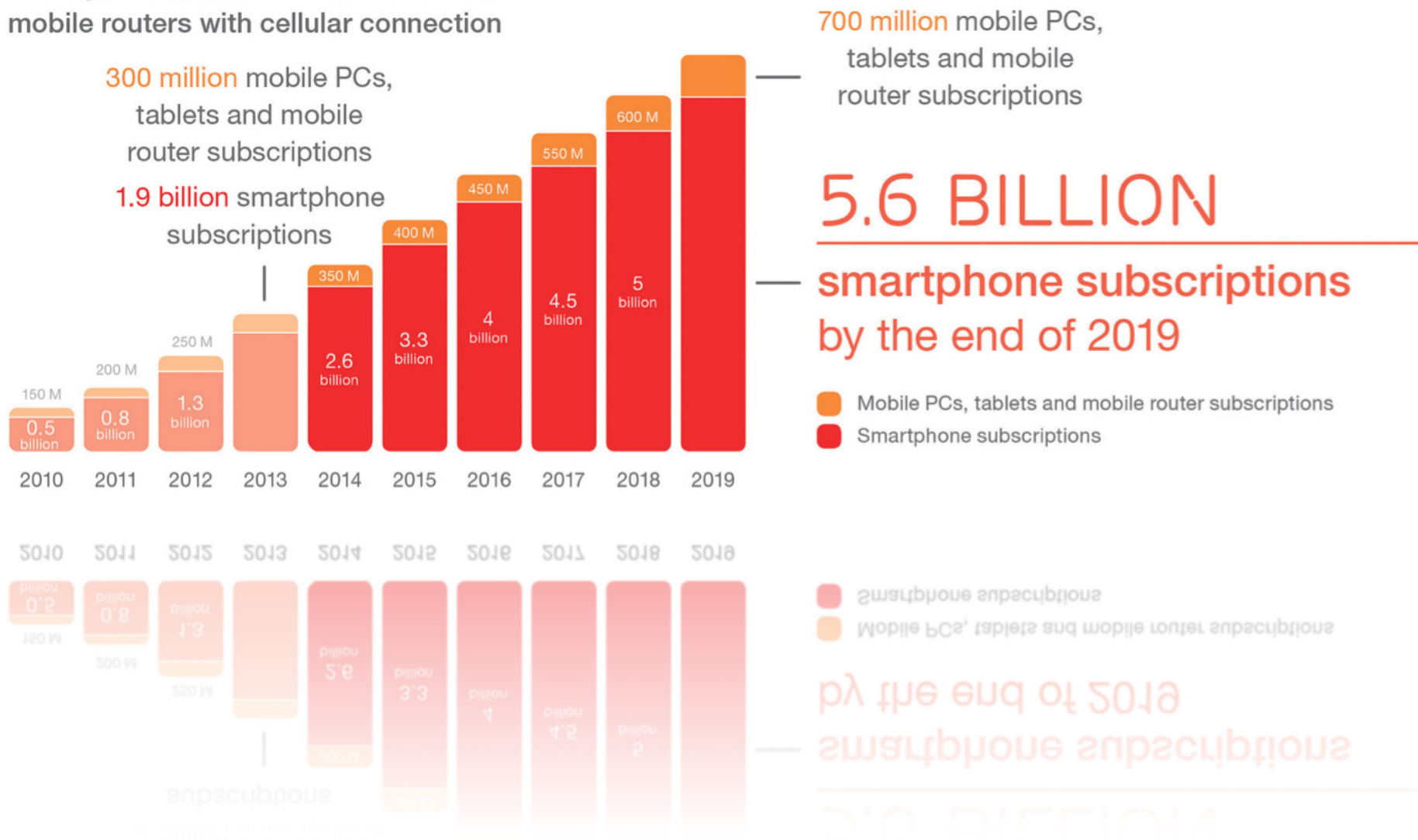
A new version of the [init/factory](#) dataset has been added to CRAWDAD.

Contributed by Dimitri Block, Niels Hendrik Fliedner, Uwe Meier.

Measurement of the channel gain for multiple distances within a factory environment. There are two new tracesets in this version.

If you do use these data, please let us know, and you can use the DOI [10.15783/C76S3K](#) to do so. BibTeX and RIS are provided on the website.

Smartphones, mobile PCs, tablets and mobile routers with cellular connection



Crowd & sensing

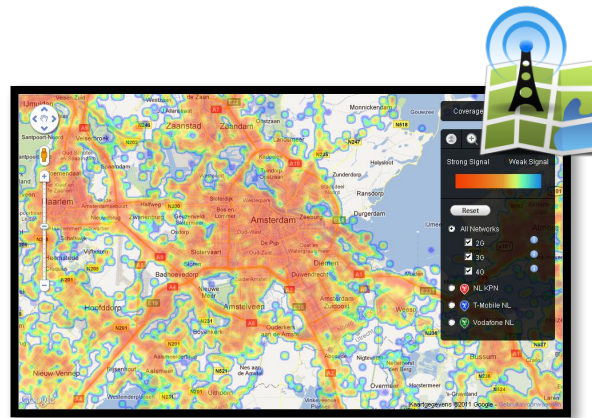
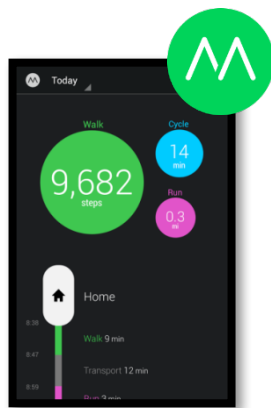


Crowd Sensing | kraʊd:sɛnsɪŋ |

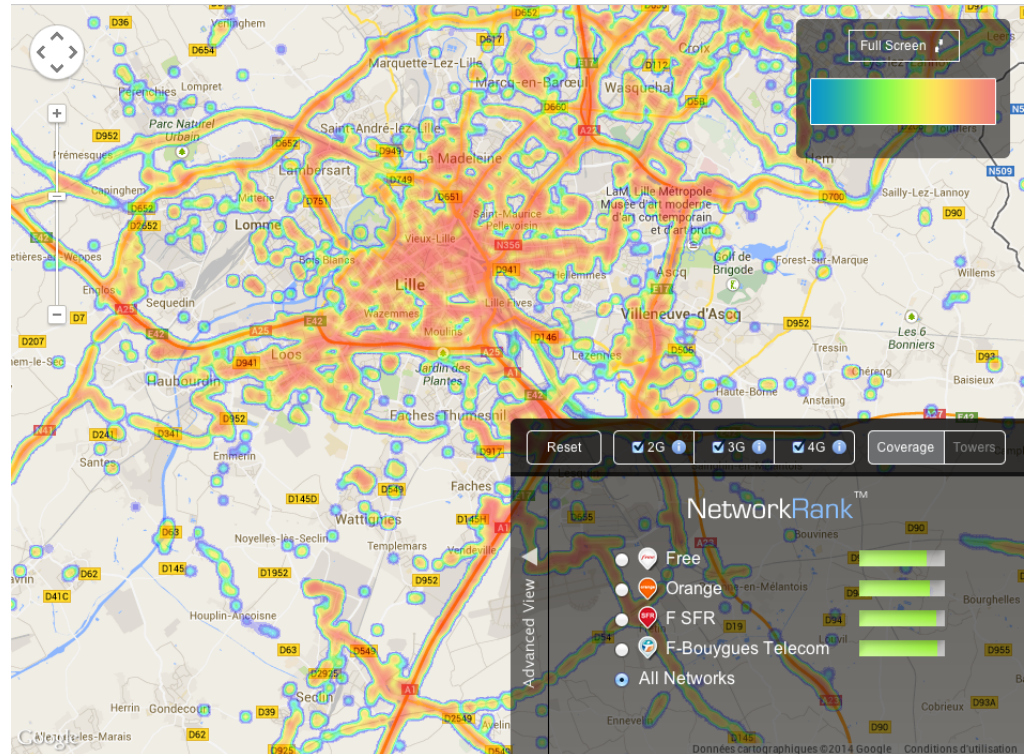
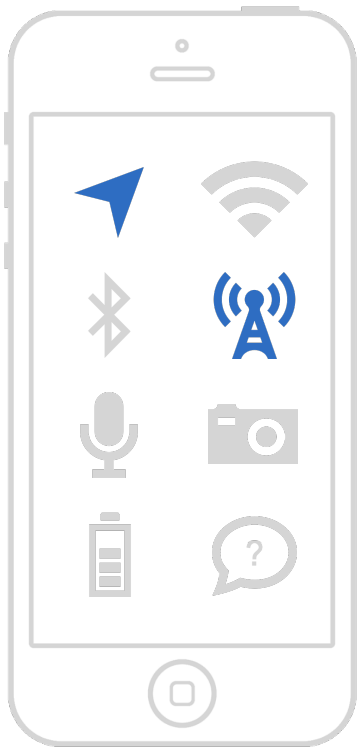
«Capability of lifting a (large) diffuse **group of participants** to delegate the task of retrieving **trustable data** from the field.

This includes:

- **Participatory sensing** involves the user in the sensing task (eg. surveys)
- **Opportunistic sensing** uses mobile sensors carried by the user (eg. Smartphones)»

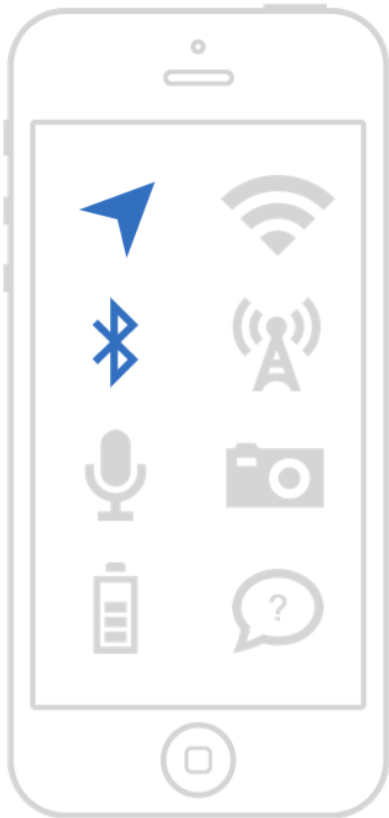


Applications to data visualisation

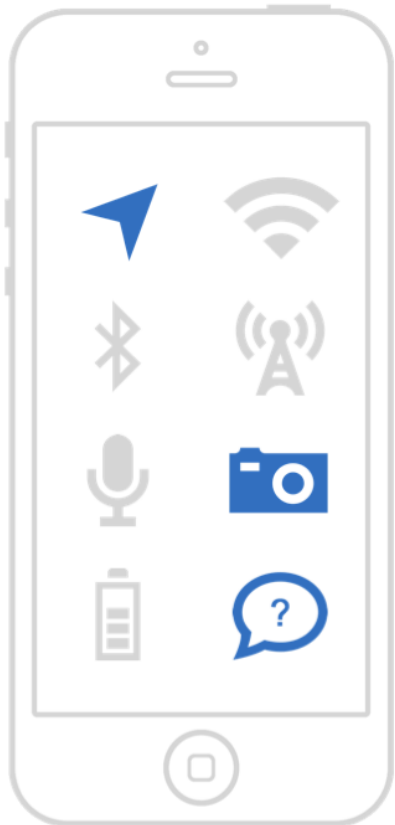


source: <http://opensignal.com>

Applications to IoT monitoring



Applications to crowdsourcing

An advertisement for 'clic and walk PRO'. The background is a blurred image of a woman, Bernadette, who is 64 years old and a ClicWalker. She is wearing a blue top and a purple scarf, and is holding a smartphone. The text on the ad reads: 'Obtenez vos données marketing et commerciales en temps réel & en photo', 'Adoptez la vision Consommateur', and 'Confiez-nous une mission'. There is a play button icon and a small 'Devenir ClicWalker' button. The language is set to 'Français'.

Obtenez vos données marketing et commerciales en temps réel & en photo

Adoptez la vision Consommateur

Confiez-nous une mission

Devenir ClicWalker

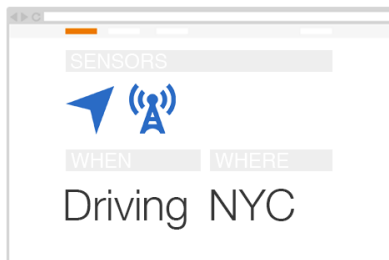
Bernadette 64 ans
ClicWalker

source: <http://fr.clicandwalk.com>



apisense

Mobile Crowd Sensing made easy!



1 Describe



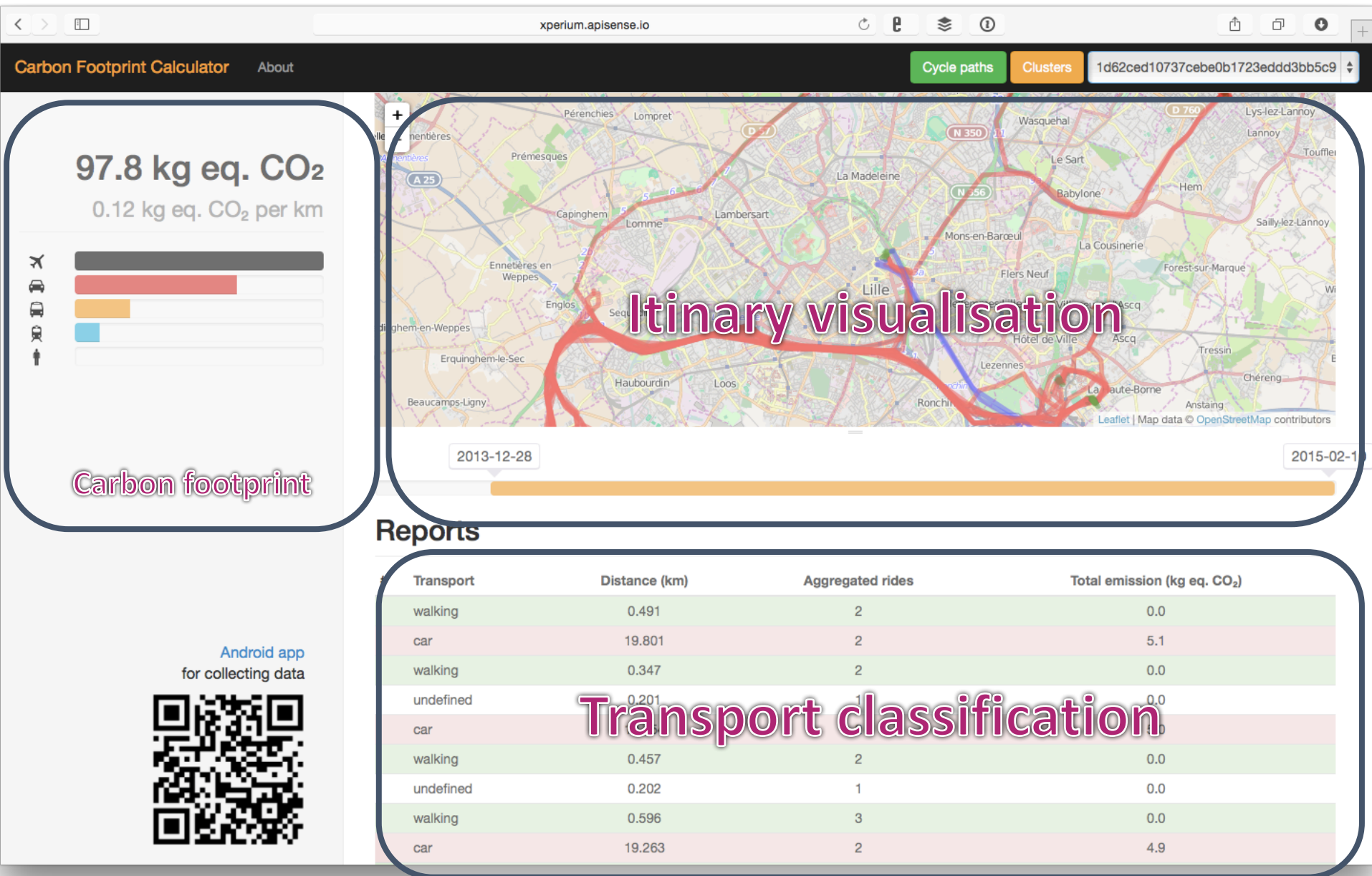
2 Collect



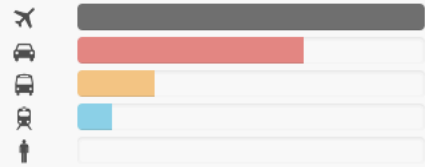
- 3 Make sense!
- Open data
- Applications
- Visualizations
- Notifications
- Studies

<http://apisense.io>

Xperium : Mobility Analysis



97.8 kg eq. CO₂
0.12 kg eq. CO₂ per km



Carbon footprint

Android app
for collecting data



Itinerary visualisation

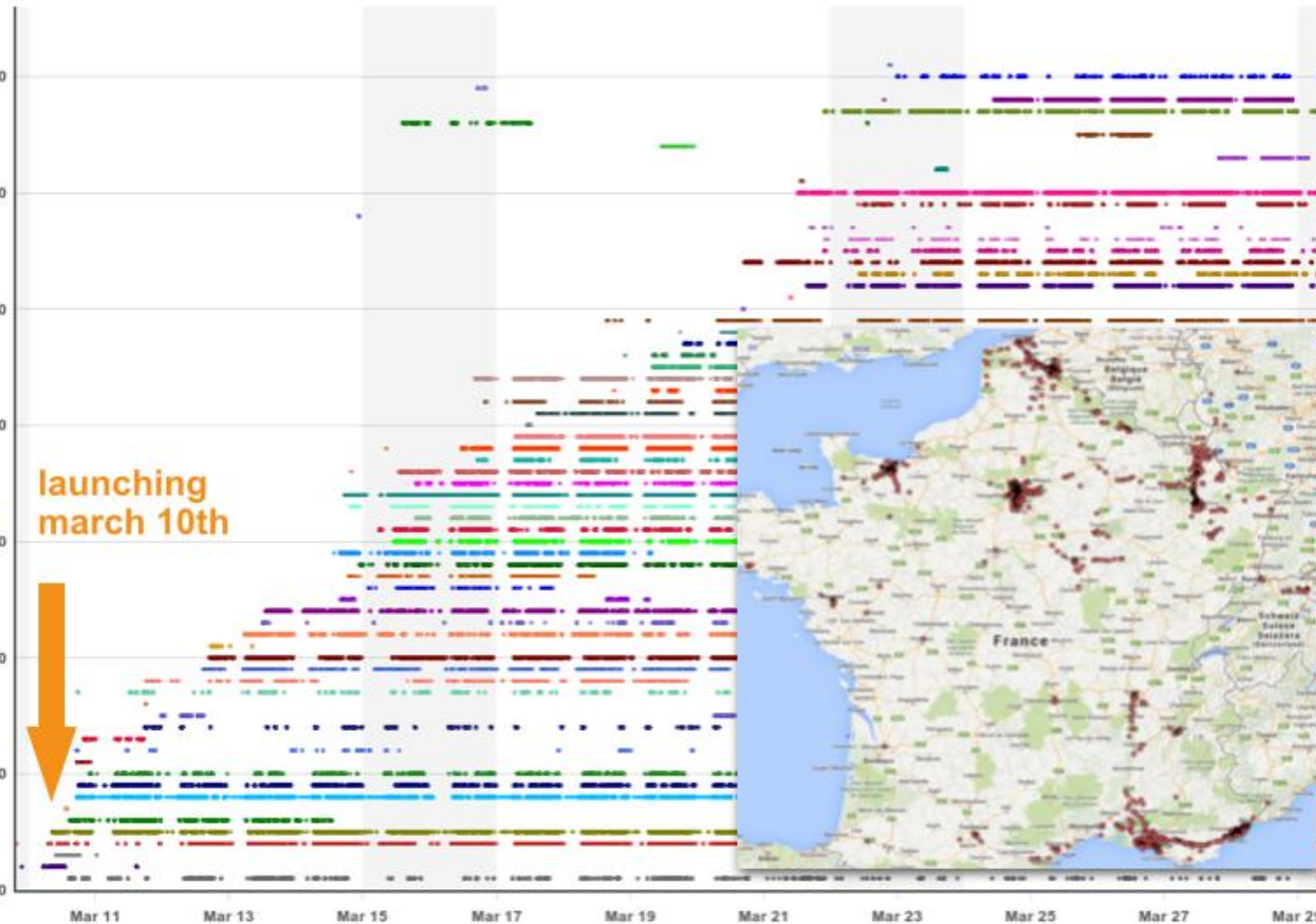
Reports

Transport classification

PRACTIC : Human Analysis

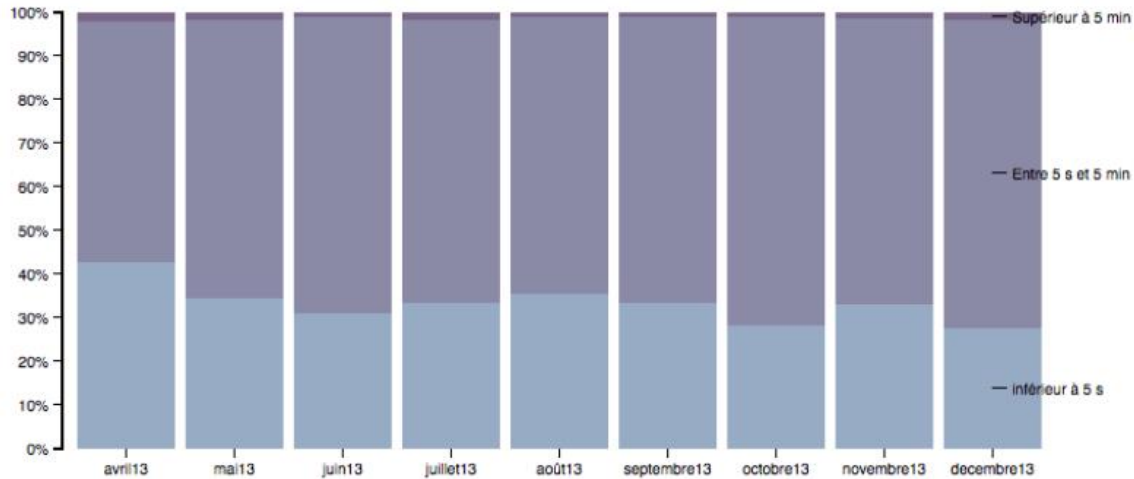
PRACTIC jeu-concours (march 10th - april 21th 2014)

All Campaigns (except Caen)



112 371 of data	or 39 days of data per user (average)
97 volunteers	Of which : - 64 % male - 80 % age under 30 - 73 % single - 35% income < 1500€/m.
68 % of students	Of which : - 43% Computer Sc./ingeneers - 22% Communication
14 device brands	Of which : - 41% Samsung - 24% LGE - 12% Sony
48 device models	Of which : - 12% LGE Nexus 5
13 telecom operators	Of which : - 77% Free, Orange, Bouygues and SFR; - 12% unknown
14 Android versions	Of which : 26% in 4.4.2

Frequency and duration of sessions on a smartphone and a tablet (occurrences of the number of sessions according to 3 levels of duration)



Jeu de données d'un smartphone ▾

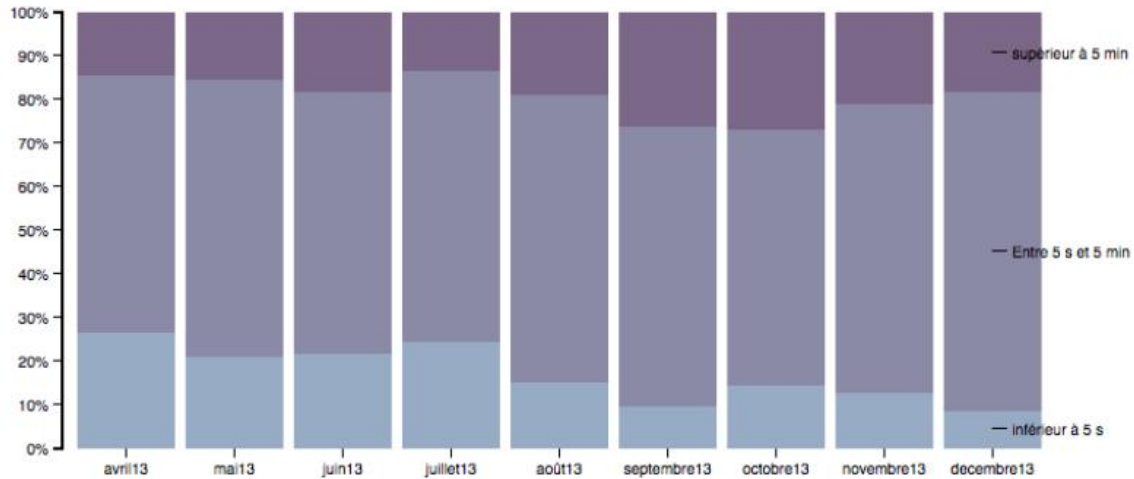
Première donnée le 19 avril 2013

- Avril : 2371 sessions sur 12 jours
- Mai : 3579 sessions sur 25 jours
- Juin : 1000 sessions sur 4 jours
- Juillet : 7090 sessions sur 31 jours
- Août : 5507 sessions sur 29 jours
- Septembre : 8304 sessions sur 30 jours
- Octobre : 8188 sessions sur 31 jours
- Novembre : 6287 sessions sur 30 jours
- Décembre : 4867 sessions sur 26 jours

Soit une présence de 218 jours sur 257 (84.82%) pour 47193 sessions

Moyenne par jour : 216.5 sessions

Ecart-type par jour : 89.03



Jeu de données d'une tablette ▾

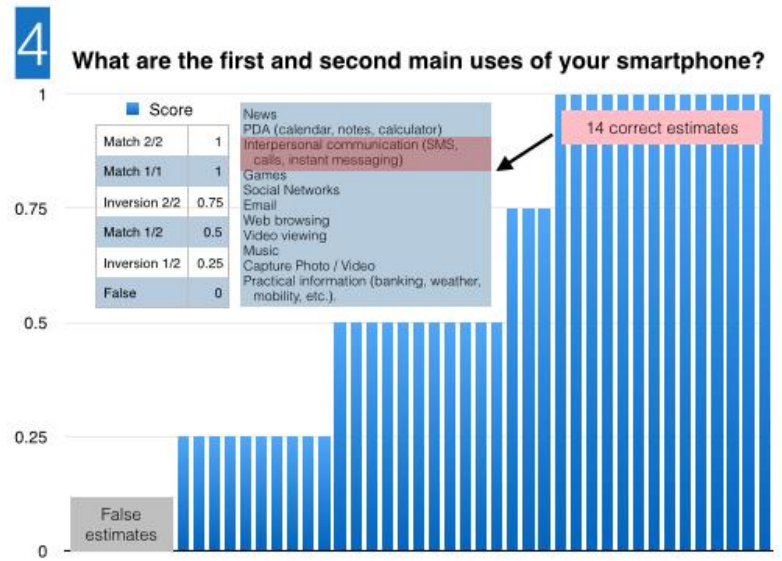
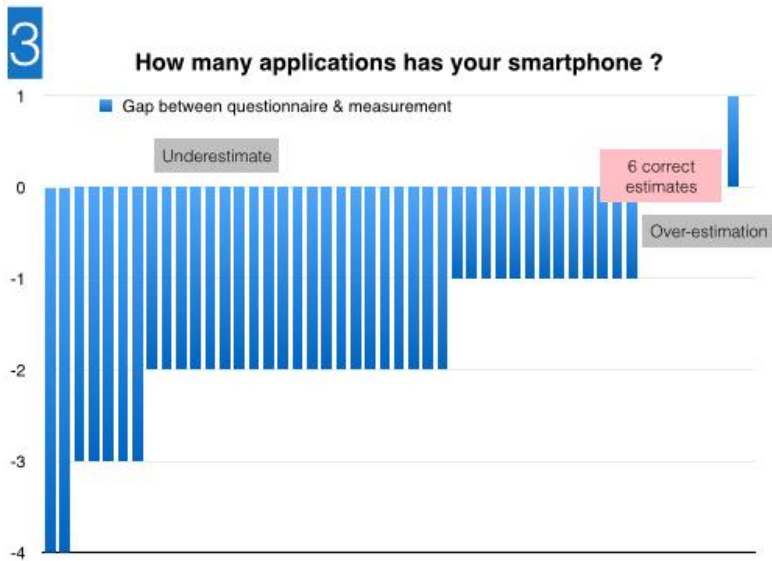
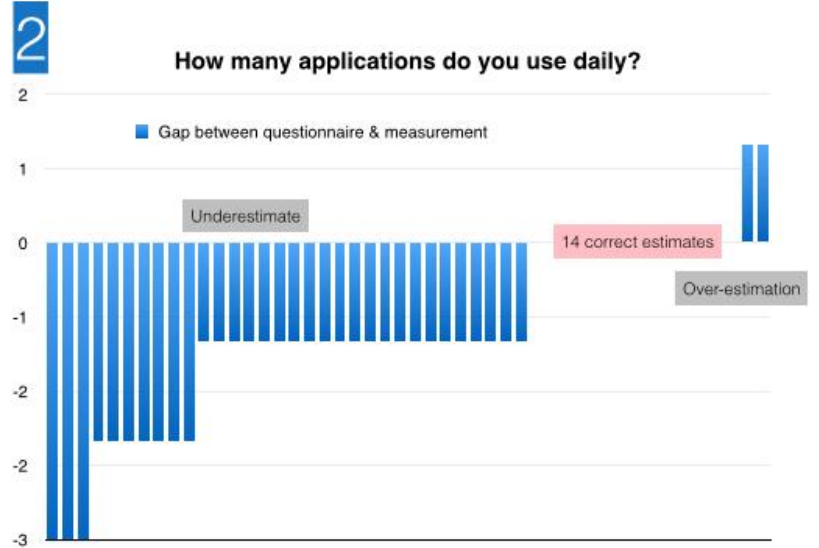
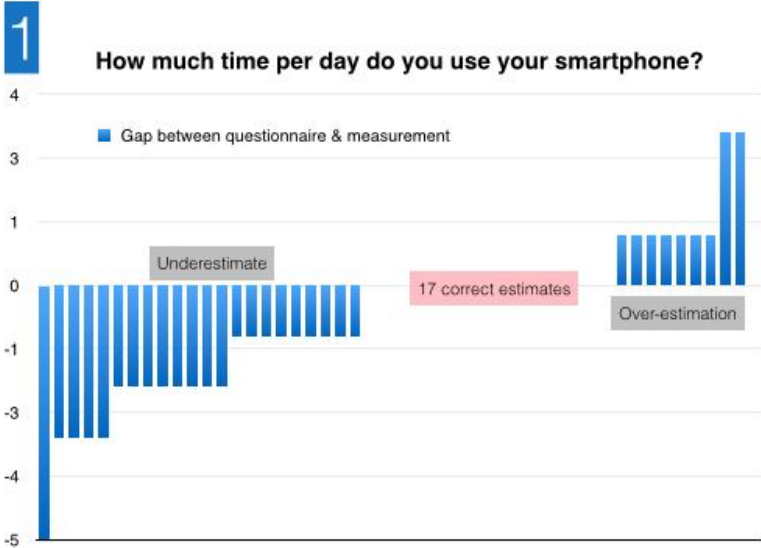
Première donnée le 11 avril 2013

- Avril : 561 sessions sur 16 jours
- Mai : 824 sessions sur 29 jours
- Juin : 513 sessions sur 27 jours
- Juillet : 688 sessions sur 25 jours
- Août : 449 sessions sur 24 jours
- Septembre : 387 sessions sur 29 jours
- Octobre : 288 sessions sur 27 jours
- Novembre : 338 sessions sur 21 jours
- Décembre : 218 sessions sur 26 jours

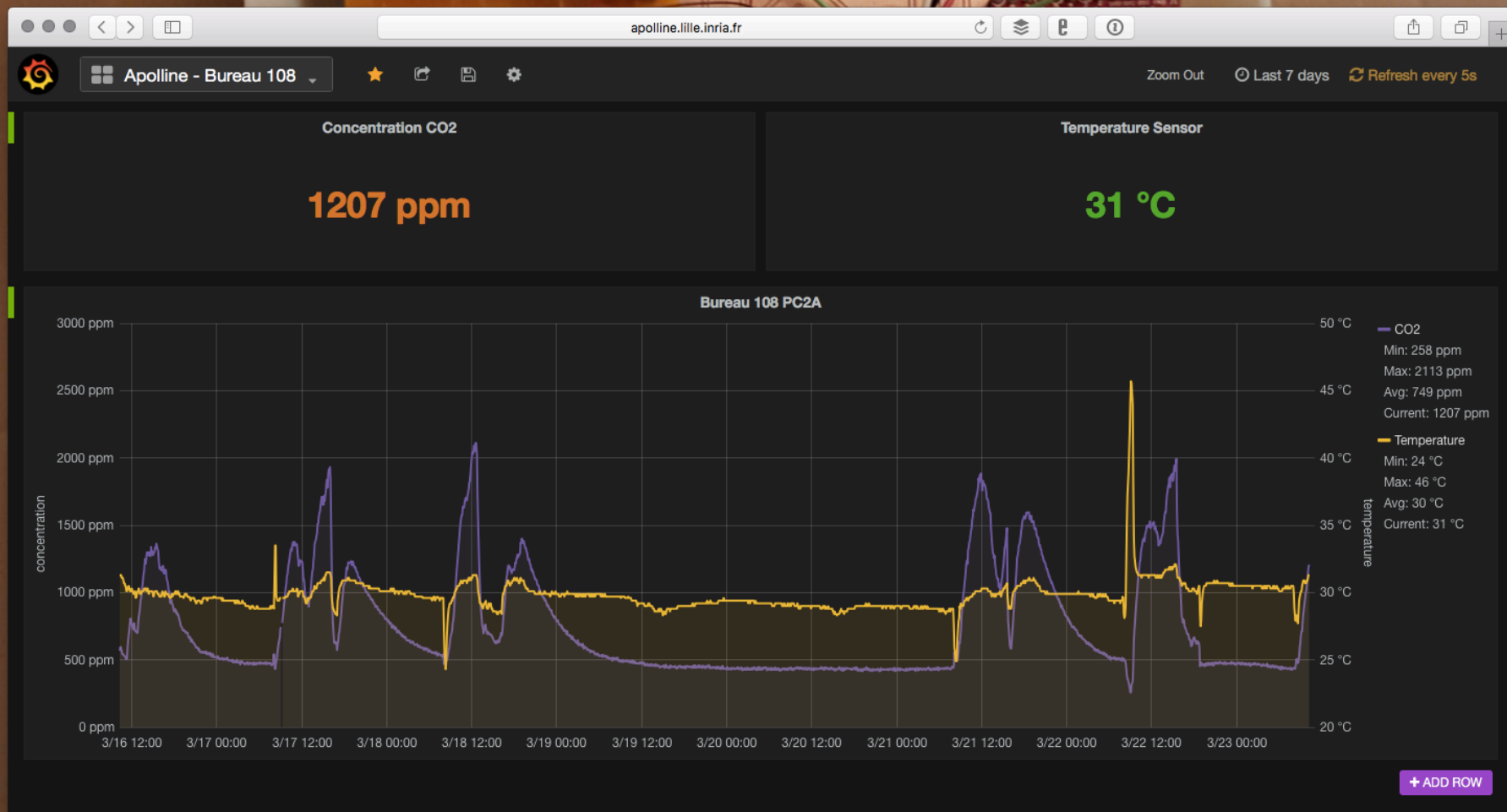
Soit une présence de 224 jours sur 265 (84.5%) pour 4266 sessions

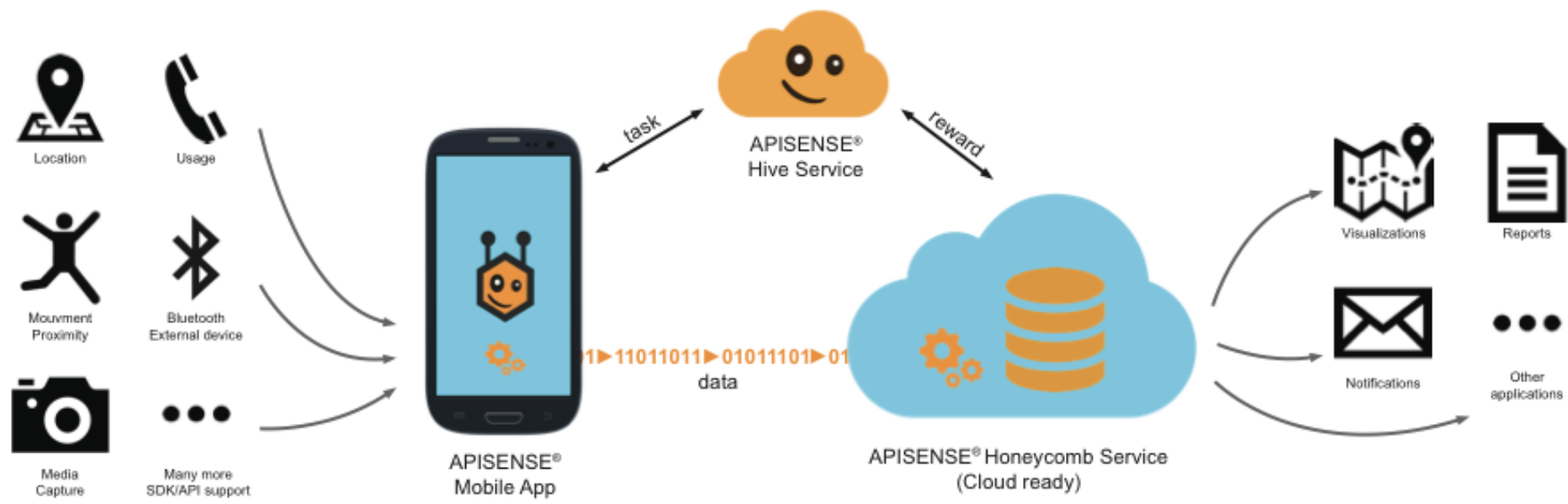
Moyenne par jour : 19 sessions

Ecart-type par jour : 17.34



OSCAR : Air Quality Analysis





INPUT

PLATFORM

OUTPUT

Data

Publish

Store



Process



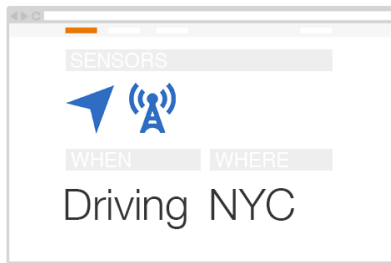
Code

Deploy

Sync.

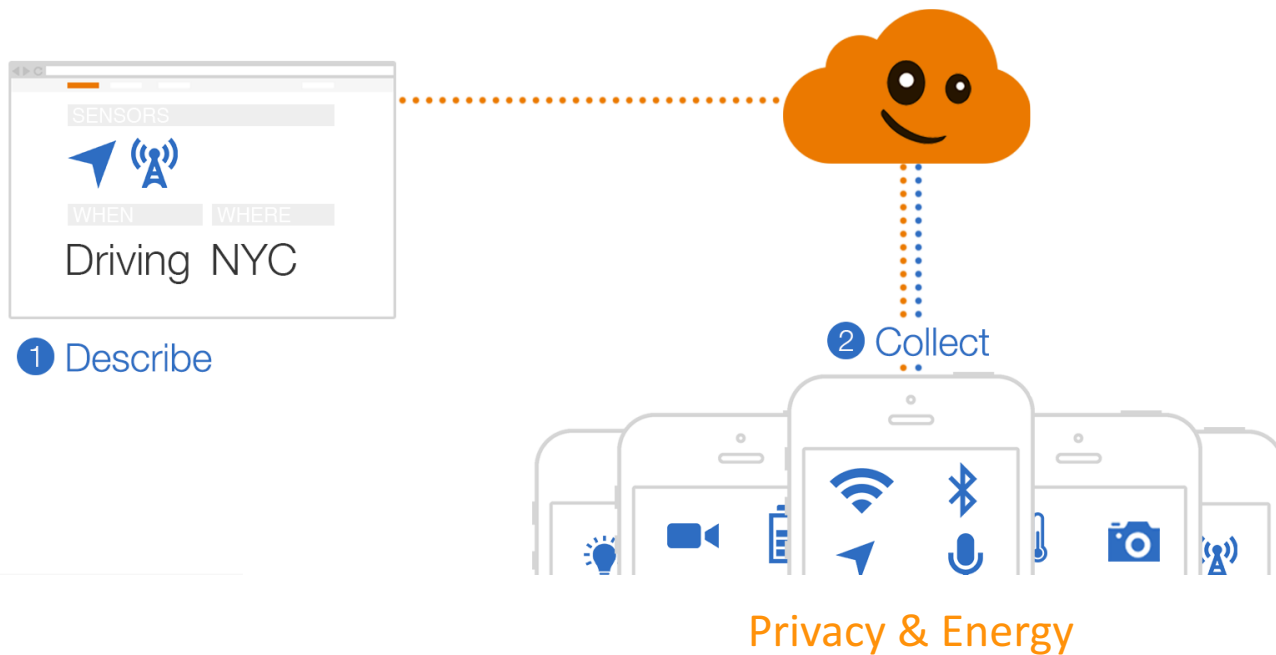


How does it work?

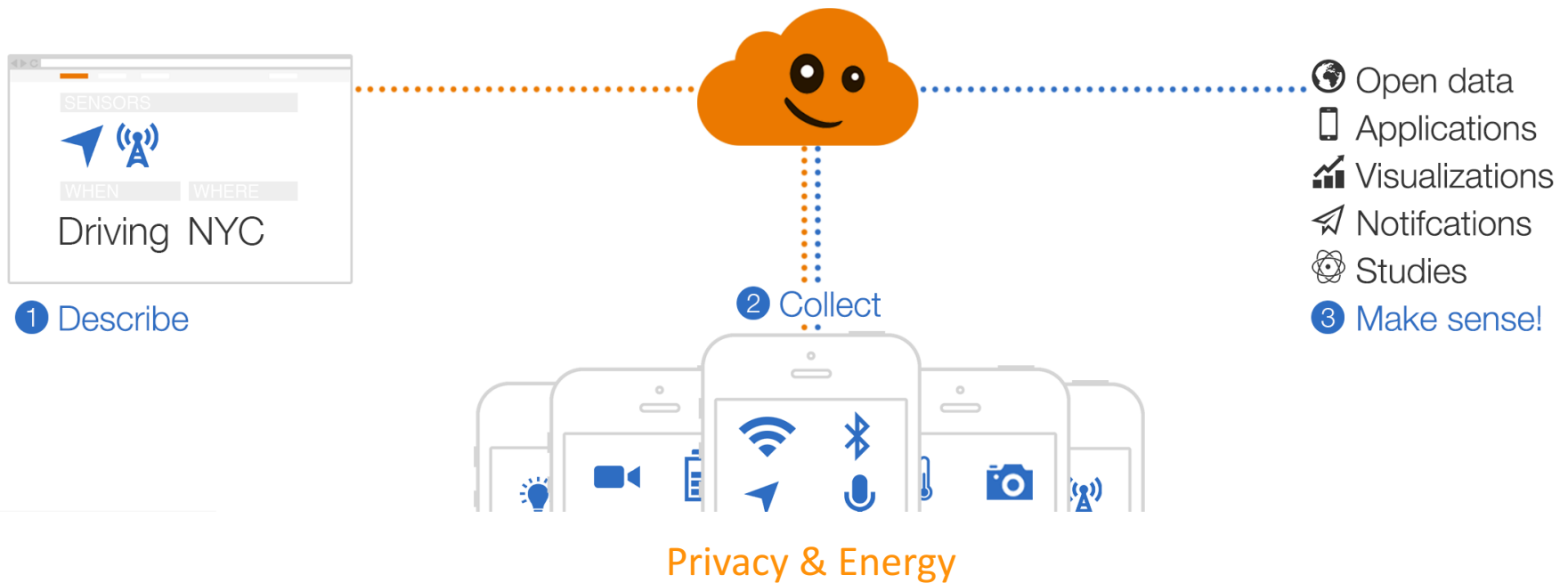


1 Describe

How does it work?



How does it work?



play.google.com

Applications

Catégories ▾ Accueil Classements Nouveautés

Mes applications

Acheter

Jeux

Famille

Choix de l'équipe

Compte

Mon activité Play

Ma liste de souhaits

Utiliser un code

Acheter une carte cadeau

Guide à l'usage des parents

Bee

APISENSE Outils

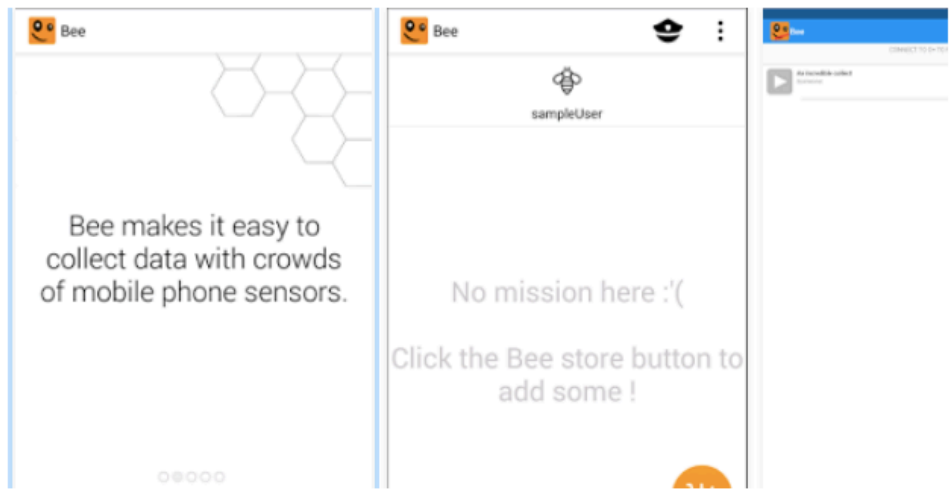
★★★★★ 3

3 PEGI 3

⚠ Vous ne disposez d'aucun appareil.

🔖 Ajouter à la liste de souhaits

Installer

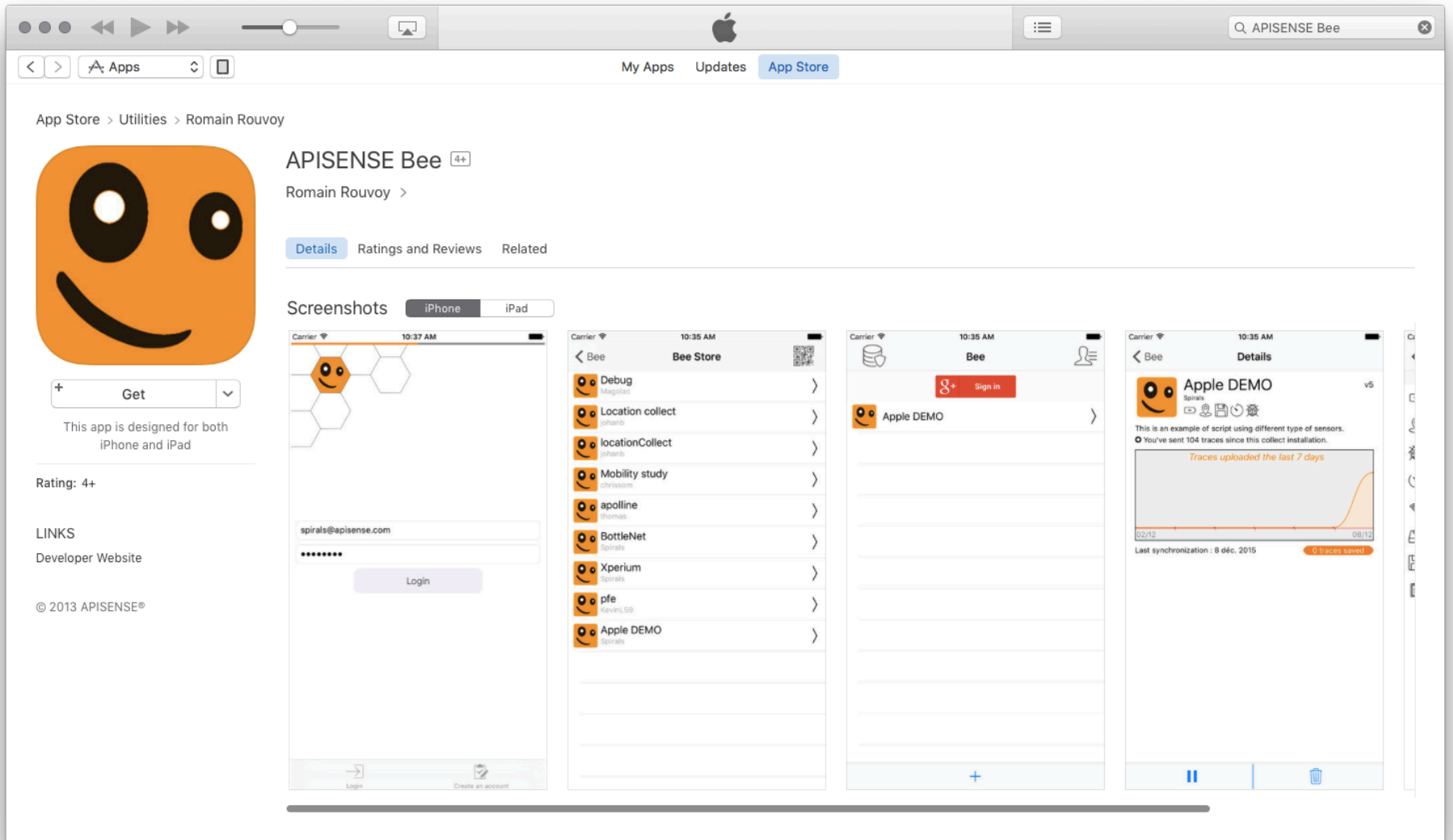


Traduire la description en Français à l'aide de Google Traduction ?

Traduire

A crowdsensing solution.

Resources:



Collect data easily with crowds of mobile phone sensors. Make sense and innovate on top of real world data feedback, in real time!



Login

[Register](#)

Spirals

.....

Login

[Forgot password?](#)

Tweets by @APISENSE

APISENSE @APISENSE

KevinL59 just published a collect called [data-airflow-test2](#) ! Contribute with Bee at onelink.to/beeapisense

19 Apr

APISENSE @APISENSE

KevinL59 just published a collect called [data-mobility-test](#) ! Contribute with Bee at onelink.to/beeapisense

14 Apr

APISENSE @APISENSE

[Embed](#) [View on Twitter](#)



BottleNet Summary Statistics Script Filters Settings

Crop panel

Test your network connection

Identifier	oPNPvJbwJ5Sv9qrBGZJ1
Visibility	Public
Version	3
Stings	

Created	17/07/2015 - 14:31
Updated	27/05/2016 - 09:01

Control panel ✓

Stop and disable the crop on clients. They won't be able to start or subscribe anymore.

Data panel

Participants	4
Synchronizations	178
Collected data	217 KB
Last upload	26/05/2016 - 13:56

[Download data](#)

QRCode


The QRCode generated represents the crop's identifier. It can be used from the Bee application to install unlisted crops or manual installation.

Embed it on your own website:

```

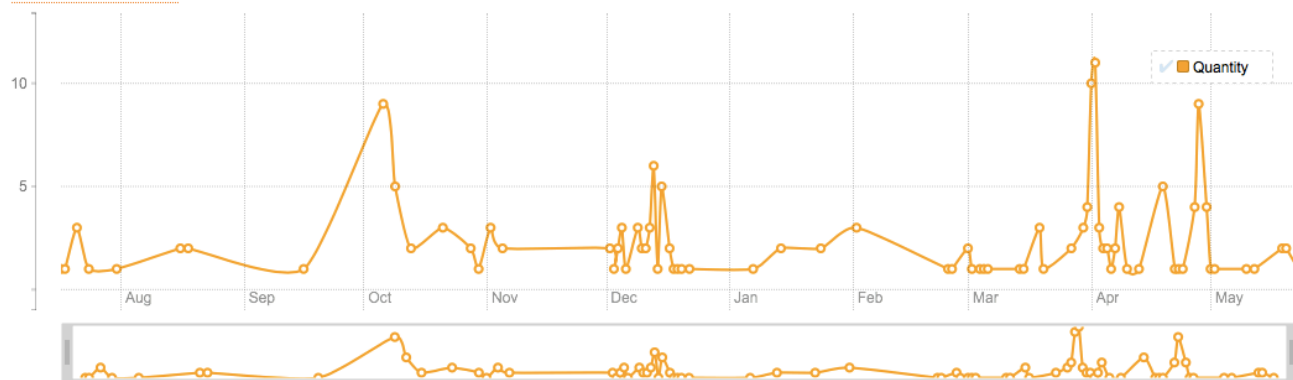
```

[Download](#)



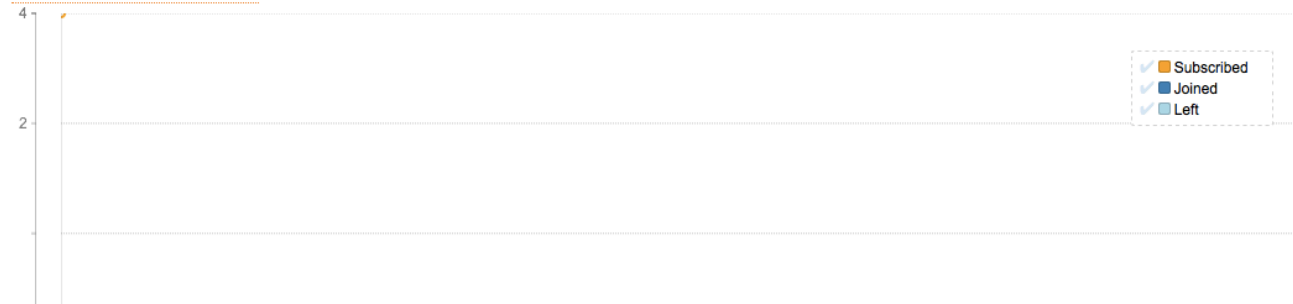
Collected data

Updated 26/05/2016 - 13:56



Subscribers evolution

Updated 26/05/2016 - 15:28



Prod v13 - 27/05/2016 11:01

APISENSE® API v1.6.0

```

1 var recorder = require("recorder");
2 var gps = require('location');
3 var battery = require("battery");
4
5 - gps.onLocationChanged({mode: gps.PASSIVE, distance: 100}, funct
6 - recorder.save({
7     'latitude': gps.latitude(),
8     'longitude': gps.longitude(),
9     'speed': gps.speed(),
10    'accuracy': gps.accuracy()
11 });
12 });
13
14 - battery.onStateChanged(function(data) {
15     recorder.sync();
16 });

```

Usage Live documentation Document

To improve your experience writing your crop, you should know some of those shortcuts !

Shortcut	Action
Ctrl+Shift+d	Deploy
Ctrl+s	Save
Ctrl+d	Show embed
Ctrl+Space	Call API
Ctrl+l	Display
Alt+u	Jump
Alt+j	Jump
Ctrl+E	Find & replace
Ctrl+Shift+E	Find & replace

Ready

Home

Classic soundtracks study
What kind of classic are you listening ?

Social interactions
This is my sweet collect

Metal soundtracks study
What kind of metal are you listening ?



Xperium

Summary

Statistics

Script

Filters

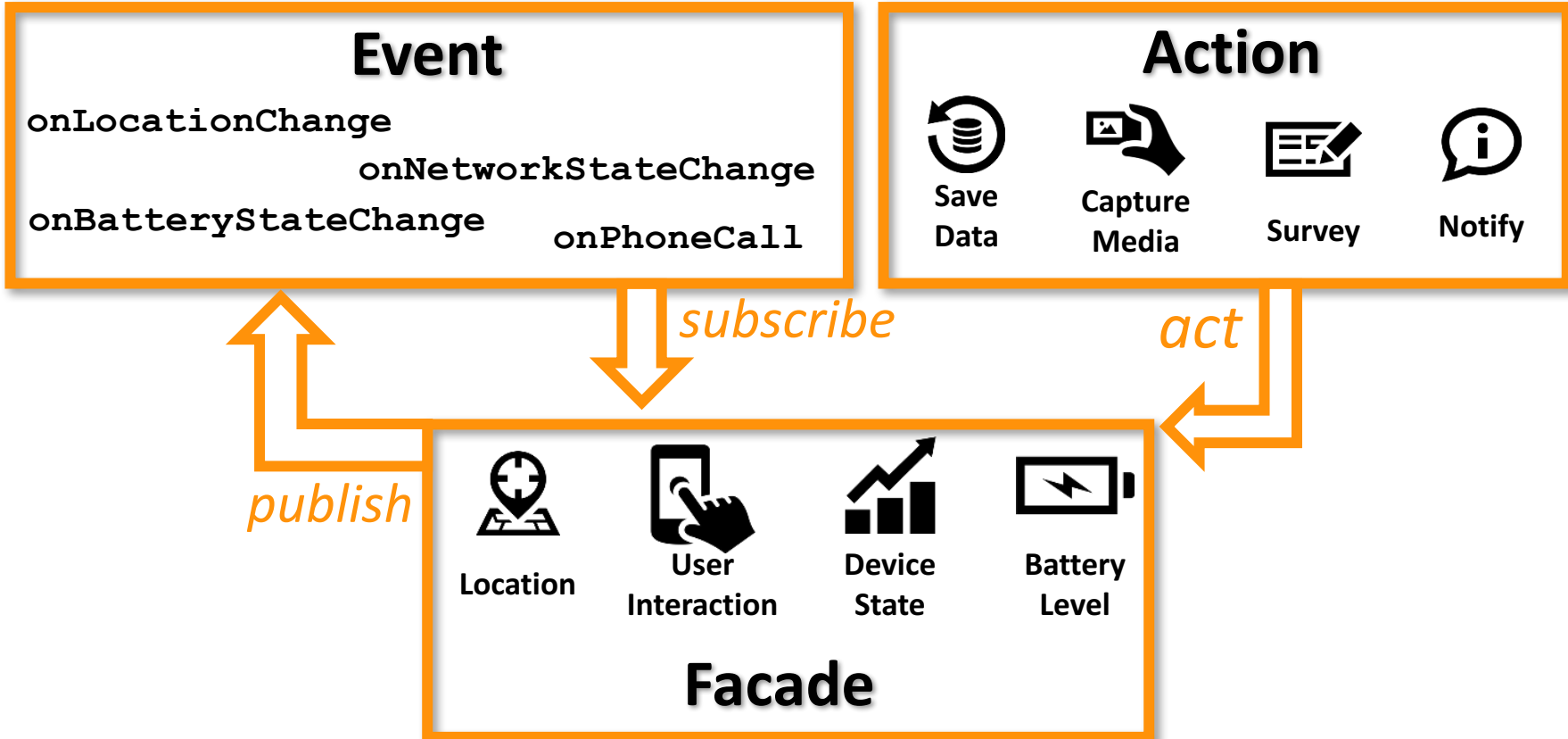
Settings



```
1- rest.prepareFilter("days", function(data){
2   var result = [];
3   var date;
4-  for each (var ele in data) {
5     date = new Date(ele.metadata.timestamp);
6     date.setHours(0);
7     date.setMinutes(0);
8     date.setSeconds(0);
9     date.setMilliseconds(0);
10-    if (result.indexOf(date.toString()) == -1) {
11      result.push(date.toString());
12    }
13  }
14  return result;
15 };
16
17- rest.prepareFilter("byDay", function(data){
18  var result = {};
19  var date;
20-  for each (var ele in data) {
21    date = new Date(ele.metadata.timestamp);
22    date.setHours(0);
23    date.setMinutes(0);
24    date.setSeconds(0);
25    date.setMilliseconds(0);
26-    if (result[date] == undefined) {
27      result[date] = [];
28    }
29    result[date].push(ele.body);
30  }
31  return result;
32 };
33
```

✓ Ready

Device-level Sensing Task



Device-level Sensing Task



```
var location = requires('location');  
var trace = requires('honeycomb');  
var telephony = requires('gsm');
```

Façades



```
location.onLocationChange(function(event) {
```



```
    trace.sync({  
        lat : event.latitude,  
        lng : event.longitude,
```



```
        signal : telephony.signalStrength()
```

```
    });
```

```
});
```

Event listener

Data upload

Crowd-scale Sensing Jobs

sense

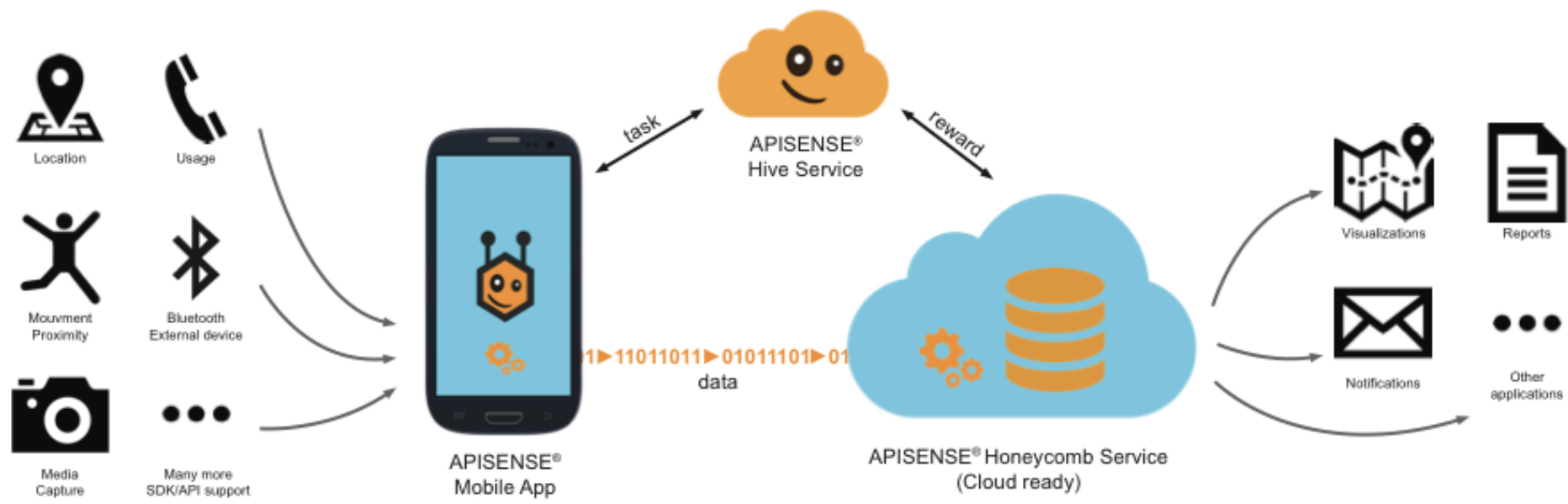
```
sense(function( ) { ... } )
```

recruit

```
accept(function( ) {  
    if (network.connectionType() == 'mobile')  
        return {battery : battery.level()};  
});  
  
ranking(function(users){  
    return users.sort('battery');  
});
```

coverage

```
geoCoverage(  
    [[50.614291,3.13282],[50.604159,3.15239]],  
    '500 m');  
  
timeCoverage('30 min','1 H');  
  
duplicate(1);
```



INPUT

PLATFORM

OUTPUT

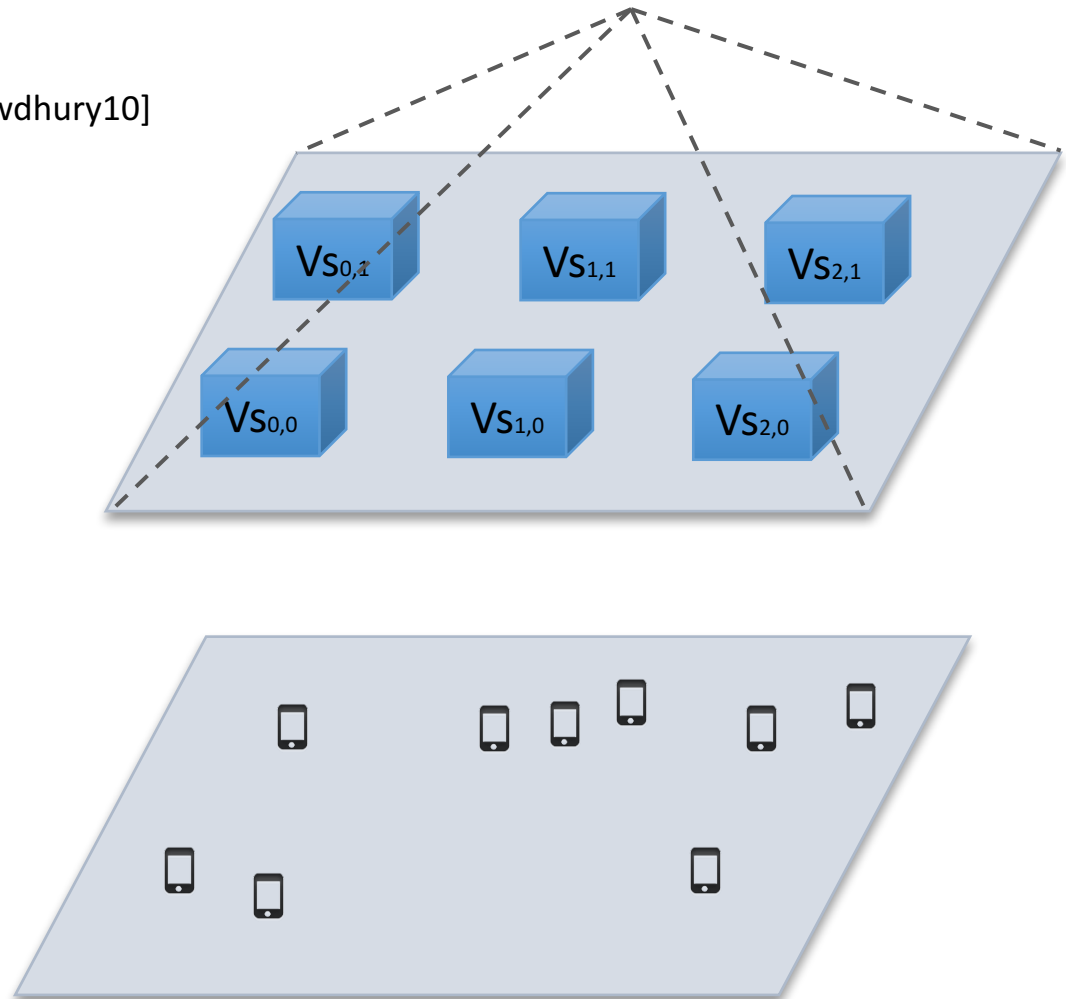
Crowd-scale Sensing Job



APISENSE®
Hive Service

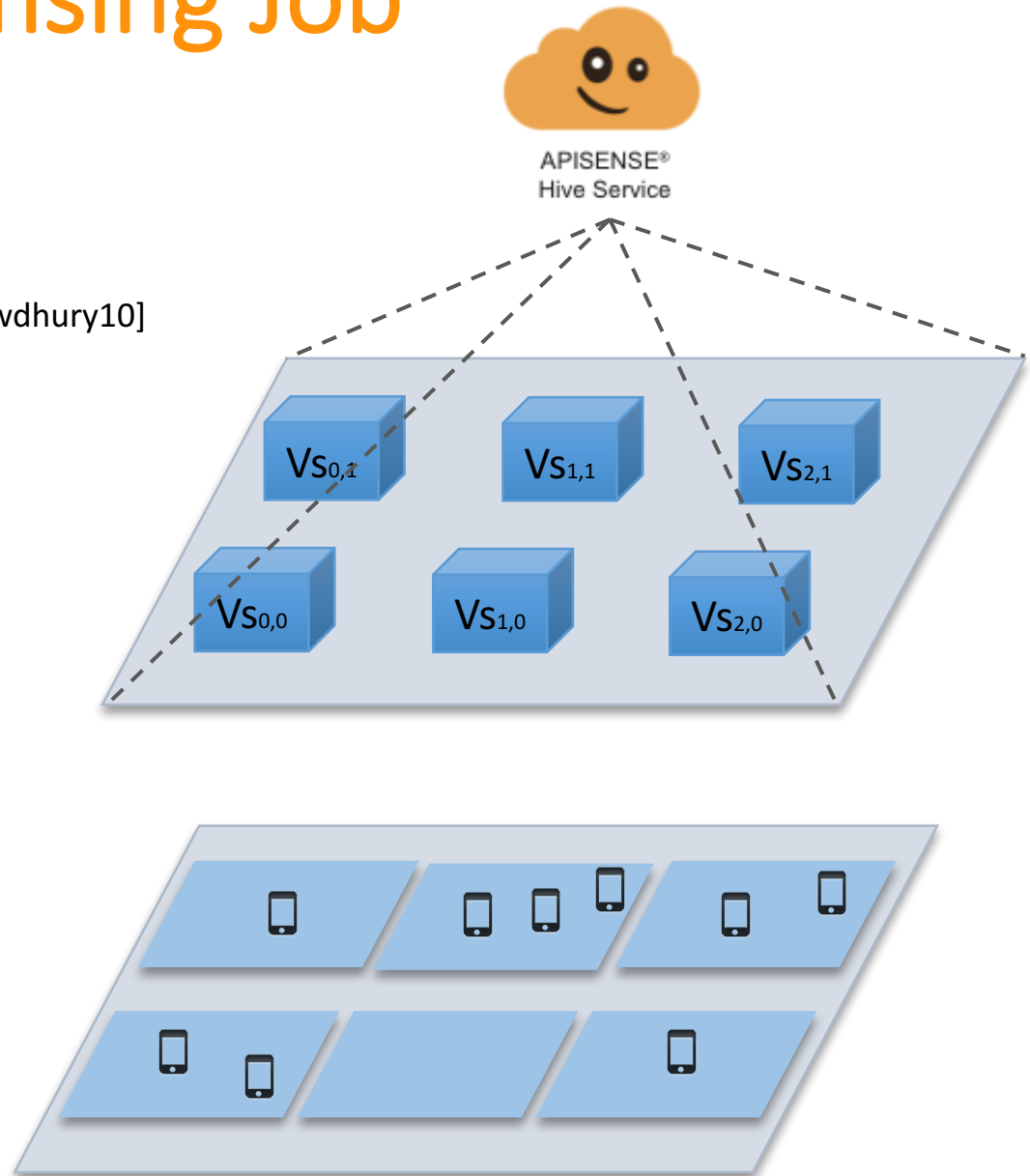
geoCoverage

1. Virtual sensor deployment [Chowdhury10]



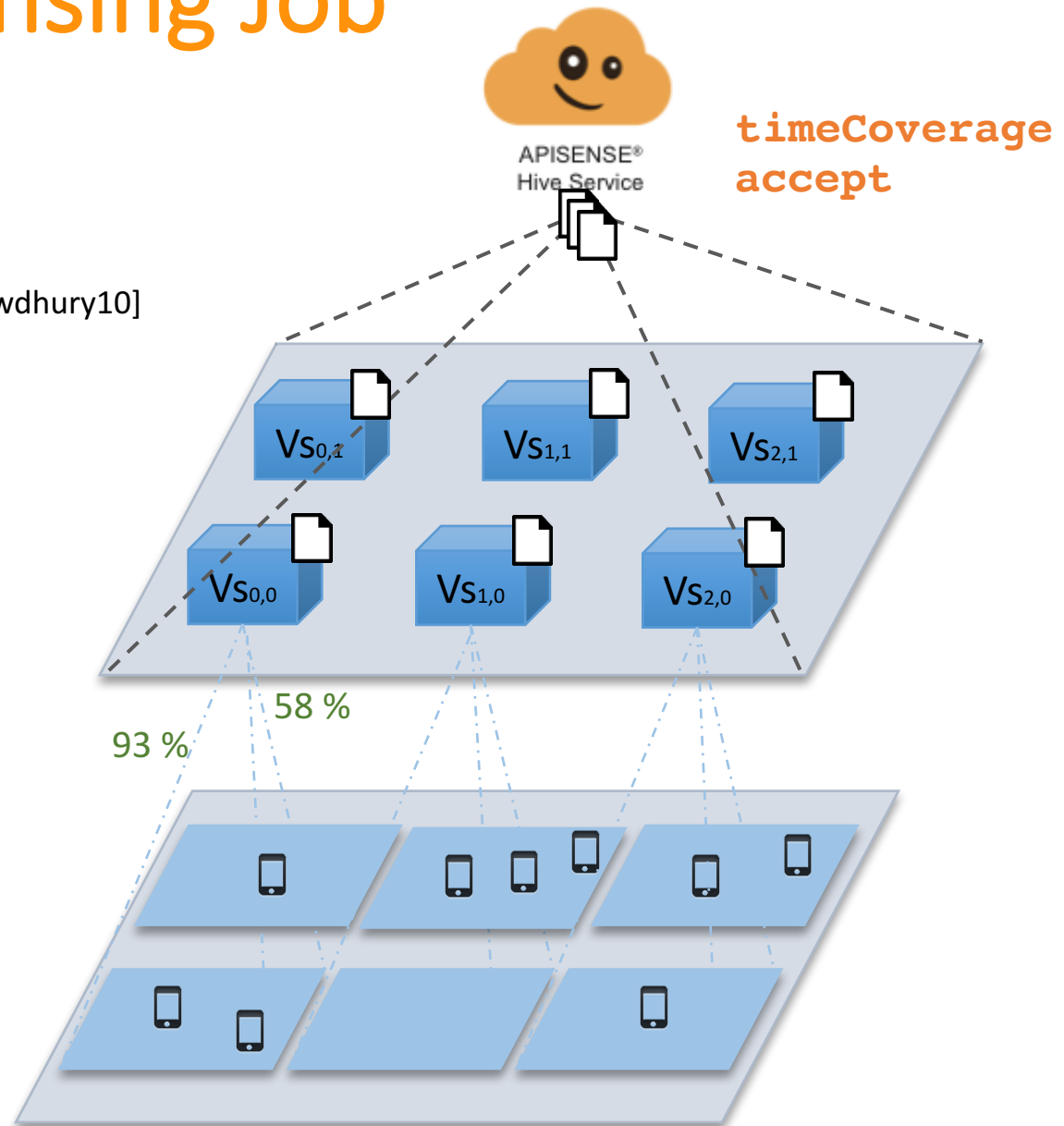
Crowd-scale Sensing Job

1. Virtual sensor deployment [Chowdhury10]
2. Connecting to physical devices



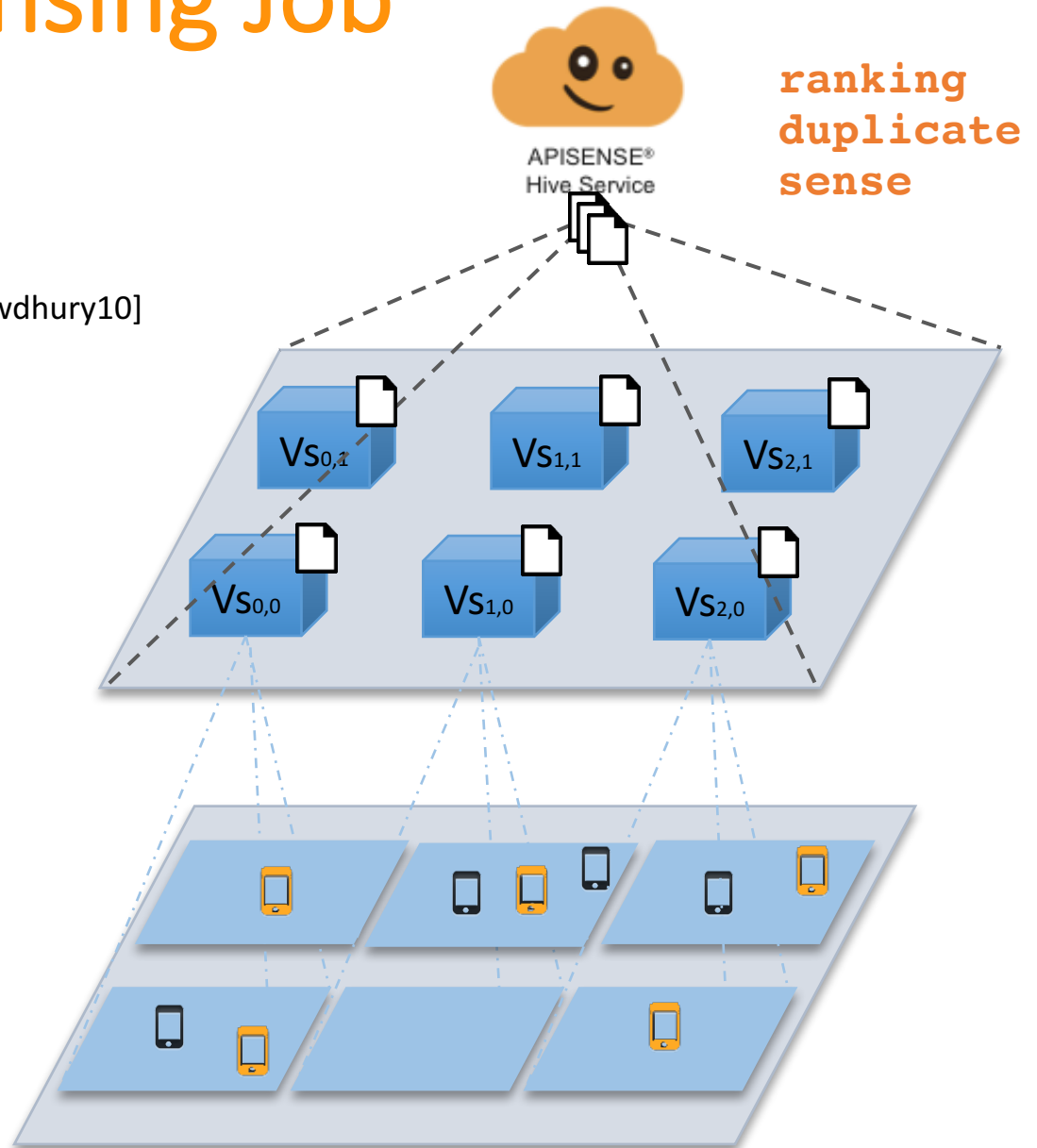
Crowd-scale Sensing Job

1. Virtual sensor deployment [Chowdhury10]
2. Connecting to physical devices
3. Assigning sensing tasks

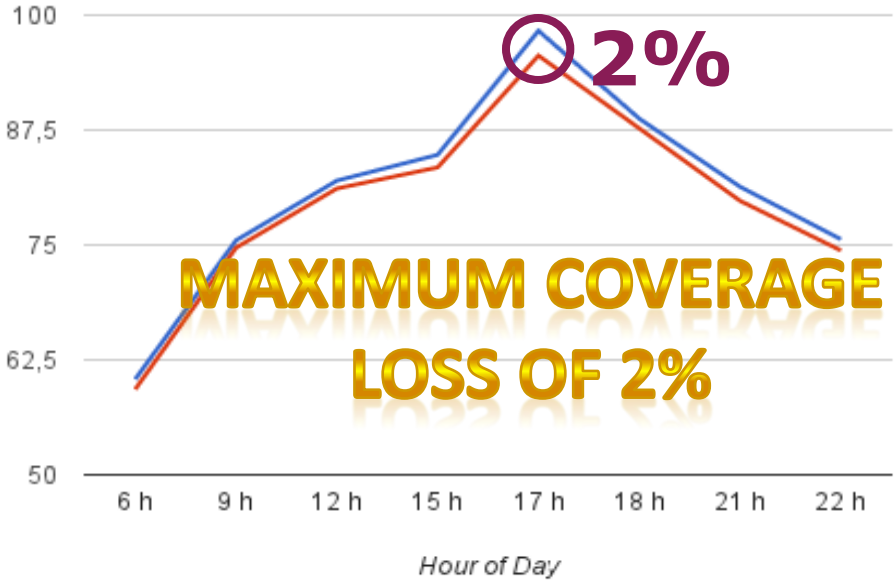
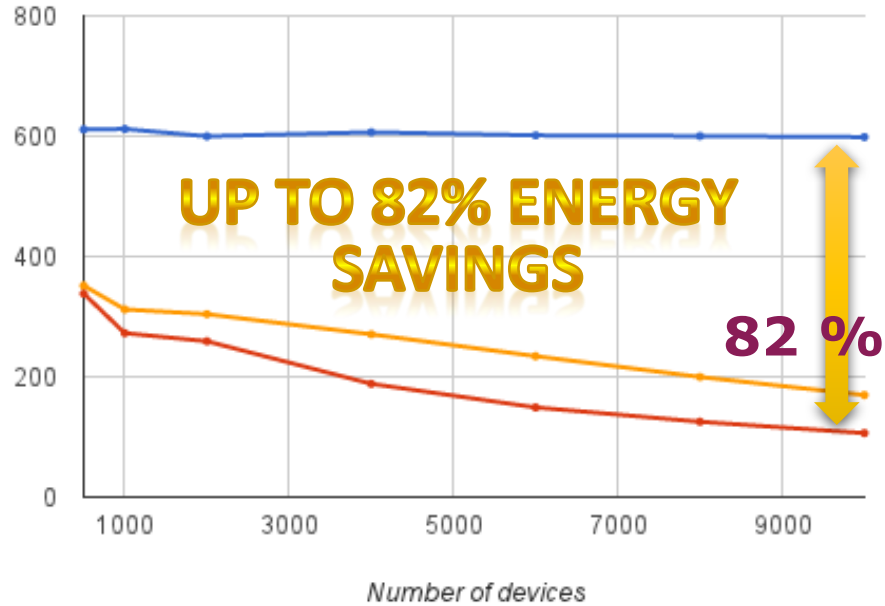
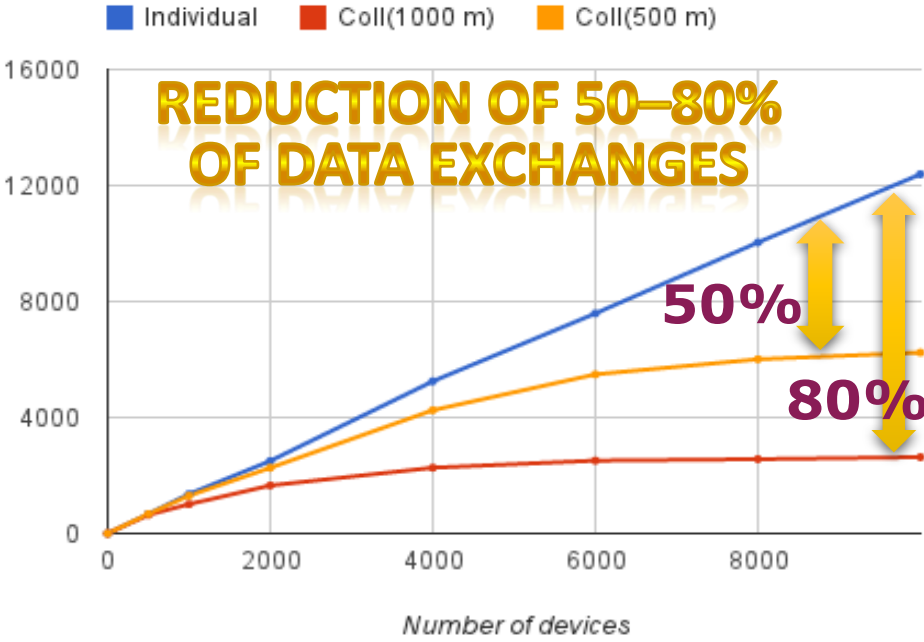


Crowd-scale Sensing Job

1. Virtual sensor deployment [Chowdhury10]
2. Connecting to physical devices
3. Assigning sensing tasks
4. Executing sensing tasks



Evaluation of APISENSE®

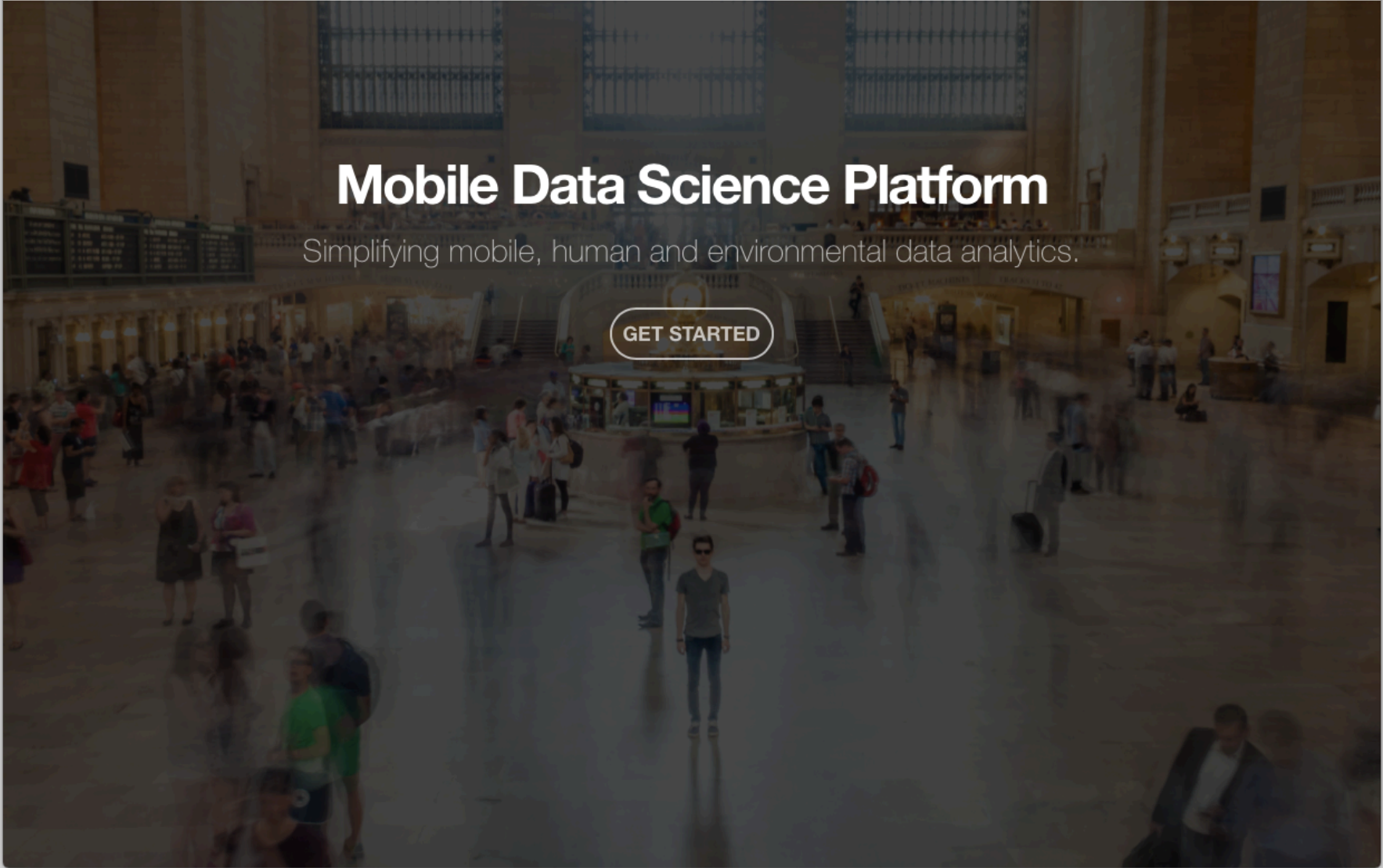


	W/B-Scanner opportunist	Citizen journalist participative
APISENSE®	4	9
Anonymsense	5	N/A
Pogo	4	N/A
MyExperience	N/A	27
Medusa	N/A	45
PRISM	??	330

Mobile Data Science Platform

Simplifying mobile, human and environmental data analytics.

GET STARTED





Book chapters

A Cloud-based Infrastructure for Crowdsourcing Data from Mobile Devices. N. Haderer, F. Paraiso, C. Ribeiro, P. Merle, R. Rouvoy, L. Seinturier. Cloud-based Software Crowdsourcing, Springer, 2014

Workshops

A preliminary investigation of user incentives to leverage crowdsensing activities. N.Haderer, R. Rouvoy and L. Seinturier. 2nd International IEEE PerCom Workshop on Hot Topics in Pervasive Computing (PerHot) (2013), pp. 199-204.

Towards Multi-Cloud Configurations Using Feature Models and Ontologies. C. Quinton, N. Haderer, R. Rouvoy and L. Duchien. 1st International Workshop on Multi-Cloud Applications and Federated Clouds (Multi-Cloud'13). April 2013, pp. 21-26.

Conferences

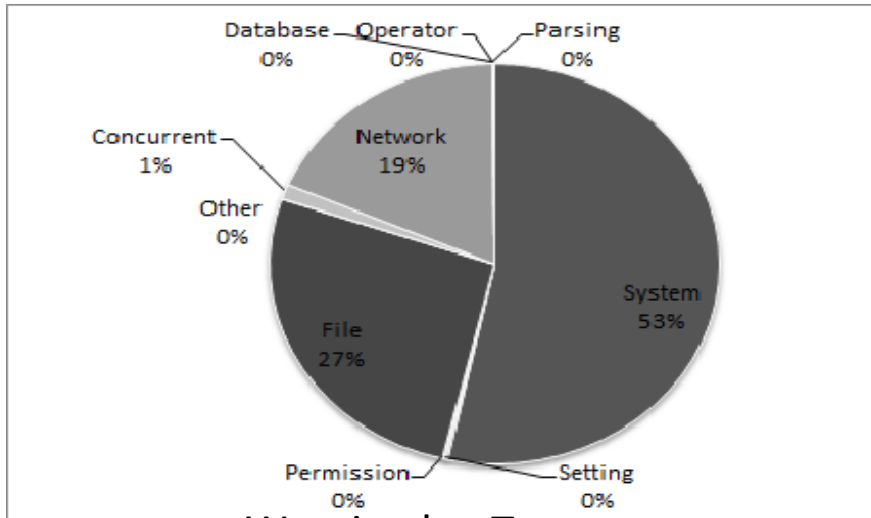
Dynamic Deployment of Sensing Experiments in the Wild Using Smartphones. N. Haderer, R. Rouvoy and L. Seinturier. 13th International IFIP 16 Conference on Distributed Applications and Interoperable Systems (DAIS), pages 43-56.

A Federated Multi-Cloud PaaS Infrastructure. Fawaz Paraiso, Nicolas Haderer, Phi- lippe Merle, Romain Rouvoy, Lionel Seinturier. In 5th IEEE International Conference on Cloud Computing (2012), pages 392-399.

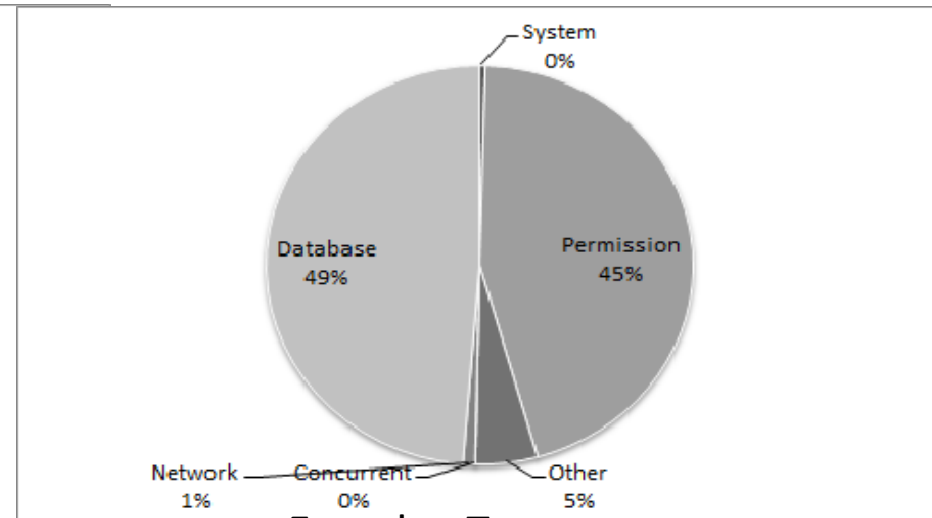
Dissemination

APISENSE : Crowd-Sensing Made Easy. Nicolas Haderer, Romain Rouvoy, Christophe Ribeiro, Lionel Seinturier. ERCIM News, ERCIM, 2013, Special theme : Mobile Computing, 93, pp. 28-29.

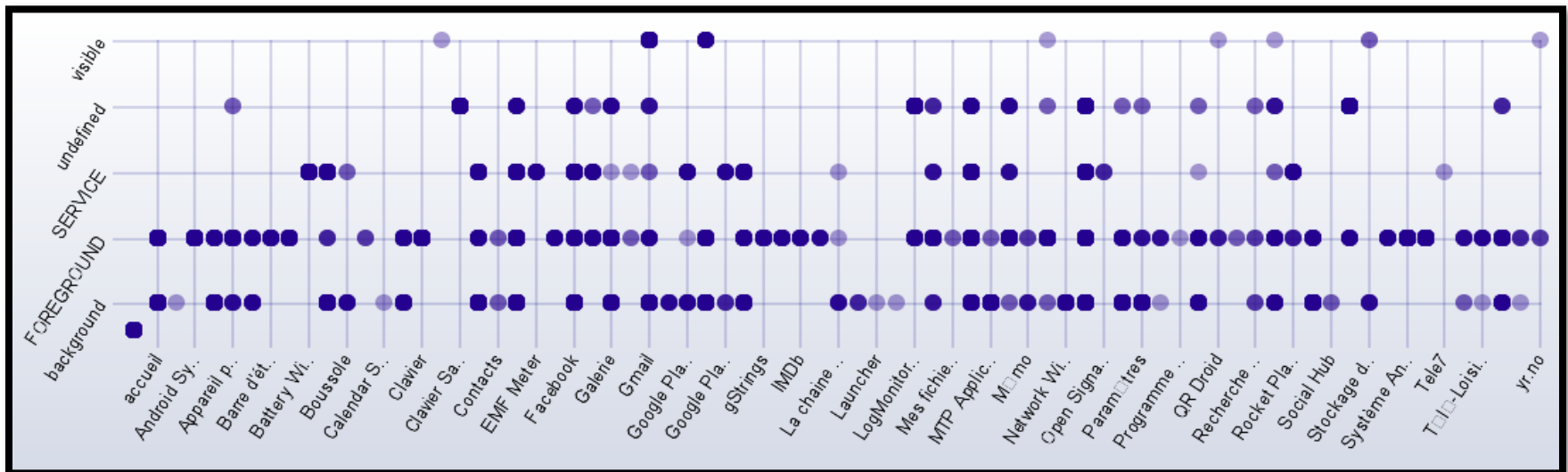
Collecting exception in the wild



Warning log Taxonomy



Error log Taxonomy



Assessing Machine Learning Models

- User context recognition implementation : ~ 30 lines

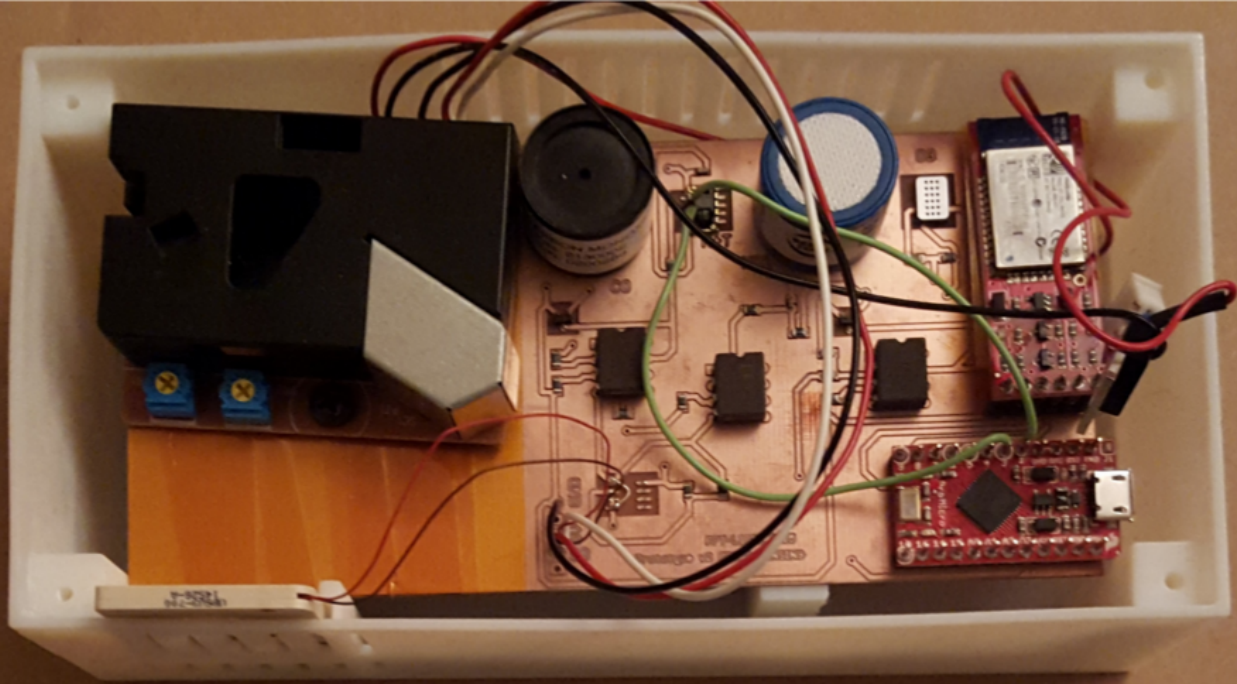
```
...
accelerometer.onChange(function(acc) { buffer.push(acc) });
// Learning phase
dialog.display({ message: "Select movement", spinner: classes },function(pattern){
  accelerometer.onChange(function(acc) { buffer.push(acc) });
  sleep('5s')
  model.record(attributes(buffer), pattern);
  buffer = new Array();
  return;
});
...
// Exploitation phase
time.schedule({ period: '5s' }, function() {
  trace.add({
    position: model.evaluate(attributes(buffer)),
    stats: model.statistics() });
  buffer = new Array();
} } });
```

	Predicted class						Acc (%)
	Walk	Jog	Stand	Sit	Up	Down	
Walk	66	0	4	0	0	0	94,3
Jog	0	21	0	0	0	0	100
Stand	4	0	40	0	0	0	90,9
Sit	0	0	2	83	0	0	97,6
Up stair	0	0	0	0	22	0	100
Down stair	0	0	0	0	0	11	100

Representative Confusion Matrix

➔ **Incentive** : the model of a free service between *Quantified-self* and *Mydata*





Programmer un module Arduino

```
#include "Sensor.h"
#include "Module.h"
#include "Channel.h"

Channel* mlog = new LogChannel();
Sensor* sensorTmp = new Sensor(A0, "temperature", &convertTemperature);
Sensor* sensorLum = new Sensor(A2, "Lumiere", &convertLumiere);
Module* myModule = new Module();

void setup() {
    Serial.begin(9600);
}

void loop() {
    myModule->load(sensorTmp);
    myModule->load(sensorLum);
    myModule->setChannel(mlog);
    myModule->updateM();
    delay(300000);
}

int convertTemperature(int sensorTmpVal){
    float voltage = (sensorTmpVal/1024.0) * 5.0;
    float temperature = (voltage - .5) * 100;
    return temperature;
}
```